

Recent Experience with SCR Catalyst Regeneration

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SUMMARY

With over two hundred new SCR's that are expected to be installed and placed in operation on coal fired power plants in the U.S., the issues related to their efficient and economic operation become of primary importance. Since the chemical utilization in SCR systems is very close to its absolute maximum, the cost of catalyst management is the major component in SCR operating costs.

Regenerating the old catalyst, in lieu of disposing it and substituting it with a new one, can substantially reduce the cost of operating SCR units by increasing the effective life of the individual catalyst layers. Catalyst suppliers and users have worked diligently over the years to develop reliable and economic techniques for catalyst regeneration. Different methods of catalyst re-processing, mechanical cleaning, heating with special gases and washing with regenerating solutions were suggested and tested with various degrees of success. Practically all known methods required removing catalyst from the SCR box, regenerating it outside and reinstalling it. Obviously, a regeneration process which does not require catalyst removal, would be more attractive.

The in-situ regeneration method was conceived in 1994 by EnBW, one of the largest utility companies in Germany, operating more than 11,000MW of generating capacity. After eight years of following the traditional practice of replacing catalyst layers on their numerous SCR's, EnBW switched in 1996 to catalyst regeneration, after the regeneration process (ReAct™) was developed and extensively tested in lab and pilot conditions.

The distinct features of the ReAct™ technology are:

- Washing a catalyst layer within the SCR reactor with water based regenerating solution containing minor amounts of non-toxic additives.
- Recirculating the regenerating solution through the catalyst certain number of times will improve the efficiency of cleaning and minimize the amount of spent solution.
- All the parameters of the regeneration process are first optimized in the laboratory for each specific catalyst case.

ReAct™ technology is now protected by U.S. and European patents and is commercially offered in the U.S. by Enra, LLC, a joint venture of EnBW Ingenieure and HERA, LLC.

So far, 13 successful full scale applications with regeneration of over 1600 m³ of catalyst and scores of lab scale tests have proven ReAct™ as a powerful technology. Different types of catalysts have been regenerated and ReAct™ was found to be equally efficient with plate type and honeycomb type catalysts.

The effect of ReAct™ is more pronounced when the degradation of the catalyst is already substantial:

- Lower catalyst activity ($k/k_0 < 100\%$) leaves more room for improvement.
- Exponential nature of deactivation process yields more additional operating time per percent of increased activity

Two parameters are most instrumental in evaluating the efficiency of regeneration process

- Gain of lost activity, which is measured as a fraction of lost activity reversed by regeneration. Typically this parameter is in the 35 to 70% range.
- Additional operating time without catalyst replacement resulting from the regeneration process. Typically one to three years per regeneration.

Both these parameters are highly site specific and can be predicted based on the lab regeneration of representative samples and using the historic trend of catalyst activity at the power plant.

The achievable improvement differs for various mechanisms of catalyst degradation and depends on such factors as furnace type, ash composition, flue gas parameters and SCR reactor operating practices. It is predicted on the basis of the lab test results tuned from prior field experience.

The ReAct™ process has some limitations:

- Complete recovery of the initial activity ($k/k_0 = 100\%$) is not achievable, however the recovery of lost activity is usually high enough to yield a significant increase in operating time without catalyst replacement.
- If the catalyst is mechanically at the end of its lifetime, no regeneration process, however applied, can help.
- ReAct™ results for heavily poisoned catalysts at times may be measurably less than normal. Recently ReAct™ was applied to a plate type catalyst with unusually high concentrations of arsenic. A modified ReAct™ process recovered around 25% of lost activity.

Usually ReAct™ is more efficient. Operating experience shows that the ReAct™ process can be repeated several times without changing the degradation pattern of the SCR plant. For example, the power plant Heilbronn bought its last layer of fresh catalyst in 1994, and since 1996 has used the ReAct™ regeneration as a standard procedure on a regular basis. Before using ReAct™, this 700MW power plant had to replace one out of three installed layers of catalyst (~ 275 m³) at least every three years. With regular implementation of ReAct™, Heilbronn power plant savings exceed \$600,000 per year.

ReAct™ is an attractive tool for reducing the cost of operating SCR. To take full advantage of its potential benefits, power plants should follow some simple recommendations:

- For operators of existing SCRs
 - Keep information on activity (or even a sample) of the fresh catalyst.
 - Provide regular activity measurements of installed catalyst samples to establish a degradation pattern.
 - Proceed with frequent measurements of ammonia in the fly ash as an indicator of current catalyst condition.
 - Extract representative samples of catalyst in advance and arrange for their test regeneration.
 - Use the test regeneration results and the established degradation curve to make a conscious economic choice between regeneration and replacement of the worst catalyst layer.
- For owners of future SCRs
 - During the design phase consider adequate access to the catalyst layers
 - Provide sufficient space between catalyst layers (~ 6 ft)
 - Provide at least two manholes/doors between layers (2-3 ft diameter)
 - Provide some space around the SCR box to locate the temporary regenerating equipment (i.e. spray grid and collecting troughs)

To summarize - the ReAct™ process is simple, proven and economically efficient. It will be an important component of the catalyst management program at power plants having SCR systems.